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ABSTRACT

This paper reports on a survey of remedial mathematics programs offered at the college level. The paper is divided into five sections. Section I describes the sampling procedures used in the study. In Section II, the occurrence of remedial mathematics programs in the various types of institutions and some general characteristics of these programs (such as annual enrollment in both remedial and regular programs, the amount of college credit given, textbooks used, and the use of audio-visual aids and of tutors) are discussed. Section III presents a classification of remedial mathematics programs based on two aspects of instruction: the method used to present material to the students and the means of pacing the presentation. In Section IV, evaluations of the effectiveness of individual programs are given, based on each respondent's judgment of that program's success along with the percentage of students successfully completing that program. Section V discusses both the process and the results of change in remedial mathematics programs. Finally, appendices contain lists of mathematics departments identified as having certain types of non-traditional instruction in their remedial mathematics programs. (DT)

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PREPARATORY MATHEMATICS PROGRAMS IN DEPARTMENTS OF MATHEMATICS*

by

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Over the past ten years there has been a significant growth in the number of college students requiring instruction in preparatory mathematics. This growth is largely due to the combined effects of the following two changes in higher education: a shift in student career selection patterns towards service areas requiring quantitative skills and an increase in the number and proportion of students with backgrounds not typical of traditional college populations.

Meeting the educational needs created by these changes has primarily been the responsibility of mathematics departments; and consequently, preparatory mathematics programs (PMP) have become a significant part of the instructional effort of most mathematics departments, including those of many major universities. Although these changes have caused some resentment and frustration among certain faculty members, who are neither accustomed to nor trained for this type of instruction, many mathematics departments across the country have responded

*Preparatory mathematics is defined to be instruction which includes many of the following topics with an emphasis on developing manipulative skills: Arithmetic of integers, rational numbers and real numbers; exponential and radical notation; algebra of polynomials and rational expressions; linear and quadratic equations; and topics in plane geometry.

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to this educational challenge in a variety of creative ways. There have been experiments with program content. Different testing and diagnostic procedures have been devised. Numerous innovative teaching methods and classroom organizations have been tried. Additional courses have been introduced. Tutors have been deployed, both in the classroom and in learning centers. Mixed-media and other teaching and motivational aids have been developed and many types of textbooks have been written.

What have we to learn from these experiences about effective preparatory mathematics instruction? This is the central question investigated by the research on which this paper reports. A general description of the current state of preparatory mathematics programs (PMP) in this country is provided. This description includes a classification of PMP in terms of two important instructional variables each of which is determined by program design. This classification makes possible an evaluation of the relative effectiveness of the various components of these variables. This evaluation is based on the judgments of those departments with PMP having the given program components. In addition to the above considerations, this research investigates the process by which new approaches to preparatory mathematics are discovered and implemented by departments of mathematics.

This paper announces a great amount of new information about PMP in this country and introduces several techniques for studying the effectiveness of selected features of these programs. It is hoped that this work will provide a basis for further study of this important area of mathematics and, in addition, will stimulate the development of more effective instruction for the large number of college students needing instruction in preparatory mathematics.

This paper is divided into five sections. What follows is a description of the contents and major findings of each of these sections. Section I describes the main data gathering instrument used in this research. The information presented in this paper is based on a large (47%) return of a questionnaire sent to about one thousand departments of mathematics. The return is shown to be representative both geographically and in terms of the types of institutions surveyed.

In Section II, the occurrence of PMP in the various types of institutions is given, along with some general characteristics of these programs. It is found that three-fourths of the surveyed departments have PMP and that in 81% of these departments at least one-tenth of the total enrollment is in preparatory mathematics; this figure is 54% for departments in institutions which offer at least fifteen doctoral degrees annually. Other PMP characteristics described include: the policy on course credit, length of program, use of tutors and mixed-media aids, and textbooks. Some comparisons are given between PMP in two-year colleges and in larger universities in terms of these characteristics.

Section III presents a classification of PMP based on the following two programmatic aspects of instruction: The method by which preparatory mathematics material is presented to the students and the means by which the pace of this presentation is determined. This classification distinguishes twelve general instructional types of PMP. These types account for virtually all PMP found in the survey. The frequency of occurrence of each type is given along with a description of the characteristics of the more commonly occurring types. It is found that the traditionally organized classroom lecture course remains the most

common instructional type; it is used in 61% of PMP. The next most frequently found type, flexibly paced, individually presented instruction, is found in 16% of PMP. For programs using the lecture format statistics on class sizes are given.

In Section IV evaluations of the effectiveness of the main instructional types and program features are given. This analysis is based on two types of evaluative information supplied by the questionnaire respondents: A judgment of PMP success and the percentage of students successfully completing the program. It is found that PMP with the flexibly paced, individually presented type of instruction tend to be judged as more successful than are PMP with the traditional approach. This tendency is not found when evaluations are based on the reported percentage of successful students. In fact, in some circumstances, PMP with individualized approaches report lower rates of student success than do traditional programs. Among the other programmatic aspects analyzed in terms of these two types of evaluation is class size, which does not seem to greatly affect these evaluative judgments.

Section V is devoted to both the process and the results of change in PMP. It is found that three-fifths of PMP had made major changes in the last six years or were planning to make major changes. Most of this change was away from traditional instructional approaches. While two-year colleges and universities are equally likely to change, more of the recent changes have taken place in the PMP of universities; and programs with nontraditional components are a more recent occurrence in universities. The two evaluative judgments do not seem to be affected by past or planned change; however, those departments which had changed overwhelm-

ingly preferred the current approach to the older one. Factors in the change process are discussed, including sources of support and sources of information for those involved with change.

Finally, the appendix contains a list of mathematics departments which were identified by this research as having certain types of non-traditional instruction in their PMP. It is hoped that these departments will share their experiences with departments which are searching for more effective instructional approaches to preparatory mathematics. As this research has found, this type of interaction is an important source of information for developing programs. And, given the current state of higher education, it should be added that two-thirds of the departments which made major changes in their PMP did so <u>without</u> extra-departmental financial support!

I. Survey Description.

Most of the information presented here is compiled from the responses to a questionnaire sent in October, 1974, to the heads of mathematics departments of the 961 largest (as determined by enrollment figures in [13]) public and private accredited two- and four-year institutions of higher learning in the United States. In November, 1974, postcard reminders were sent to those not yet responding. By April, 1975, 450 completed questionnaires (47%) had been returned.

This return seems to be representative of the surveyed institutions. This is indicated by two facts. First, the return is geographically representative. Large and roughly equal returns were obtained from each region: Northeast, 44%; North Central, 56%; South, 47%; and West, 45%. Second, the return reflects the proportion of two-year colleges in the surveyed institutions: Of the 450 schools returning questionnaires, 157 (35%) were two-year colleges and, according to [13; Table 108] about 37% of the thousand largest schools are two-year.

Thus the information compiled from these returns would appear to provide an accurate picture of preparatory mathematics instruction in higher education. Not only does the group of institutions which returned questionnaires itself enroll about two-fifths of all post-secondary students [13; Table 108], but this group is a representative sample of schools which together enroll over four-fifths of all such students.

The individuals completing the questionnaire were asked to indicate which of the following institutional categories their school belonged: (I) Institutions which in the last three years conferred an annual average of 15 or more earned doctorates in at least three nonrelated disciplines; (IIA) Institutions which award degrees above the baccalaureate, but which are not in category I; (IIB) Institutions which award only the baccalaureate or equivalent degree; (III) Two-year institutions with academic ranks; (IV) Two-year institutions without academic ranks; Other. The results of this question are as follows, where the number of schools in the given category is indicated followed by the percentage this number represents of the total return (450): I = 70 (16%); IIA = 160 (36%); IIB = 56 (12%); III = 76 (17%); IV = 81 (18%); Other = 7 (2%).

For convenience in data reporting, we will combine categories I and IIA, calling the combination "Institutions with graduate programs" (IGP); and we will combine categories III and IV, calling the combination "Two-year colleges" (TYC).

II. Existence and General Characteristics.

Of the 450 schools which completed the questionnaire, 337 (75%) indicated that in their institution there is a PMP as defined in the introduction of this paper. Table 1 presents an analysis of this response by institutional category. Further analysis is confined to those schools with PMP.

While large numbers of schools in the category of institutions with graduate programs (IGP) and in the category of two-year colleges (TYC), 150 and 151 schools, respectively, stated they have programs as defined, there is a good

Table 1: Existence of PMP by Institutional Category

Category	IGP	IIB	TYC	All Categories
Number (% category) with PMP	150 (65%)	33 (59%)	151 (96%)	337 (75%)
Number (% category) without PMP	80 (35%)	23 (41%)	6 (4%)	113 (25%)
TOTAL	230	56	157	450

deal of variation, both between categories and among schools in the same category, of subject matter emphasis and length of the PMP. Seventy-eight schools gave some indication that a major part of their programs are devoted to instruction in arithmetic; 70 of these are TYC and 5 are IGP. Also, 76 schools indicated that their program begins with a course devoted mainly to topics of intermediate algebra; 8 of these are TYC and 60 are IGP. Similarly, a higher percentage of IGP (75%) have PMP lasting less than 18 weeks than do the TYC (34%). Fifty-four percent of all PMP are of one quarter or one semester duration (10 to 18 weeks).

Schools were asked to give the annual enrollments in their PMP. A tabulation of these responses is given in Table 2. The median size is about 400: 161 schools report less enrollment and 162 report enrollments of 400 or more. For the two main institutional categories the percentage of schools with enrollments under 400 are: IGP - 55%; TYC - 41%.

Table 2: Annual Enrollment in PMP

Students	0-99	100-199	200-399	400-799	800-1199	1200-1799	1800-2499	over 2500	No Reply
IGP	24	20	34	33	10	17	4	2	6
TYC	9	12	37	33	23	14	6	9	8
All	44	40	77	71	36	34	10	11	14

The questionnaire also asked for the total annual enrollments in all mathematics courses offered by the departments. These figures were used to compile the percentage PMP enrollment of the total mathematics enrollment. These percentages are given in Table 3. For the schools reporting data, 81% have PMP enrollment of at least 10% of total mathematics enrollment; and in 57% of all institutions, PMP enrollment is at least 20% of total enrollment. For IGP these figures are 61% and 27% (for the 39 category I institution, 54% and 15%). For TYC, 94% have PMP enrollments at least 10% of total enrollment and 85% at least 20%. These figures clearly show the different emphasis of IGP and TYC. However, even in many schools of the IGP category (in fact, even in category I schools), a large proportion of total mathematics enrollment consists of PMP students.

The questionnaire contained a question on whether college credit is given for the courses of the institution's PMP; 76% of those schools responding to this question answered affirmatively and an additional

Table 3: Percentage of PMP Enrollment of Total Mathematics Enrollment

Percent	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-99	No Reply
IGP	56	48	14	14	4	3	1	1	2	1
TYC	5	20	31	24	24	17	7	7	8	8
All	72	75	55	41	30	21	8	9	10	16

5% answered that some of their PMP courses received credit. Of the 251 schools offering credit, 110 are TYC and a number of these noted that at least some of the PMP credit could not be applied to four-year degrees. However, 77% of IGP give credit for courses in their PMP.

Very few schools devoted much time to topics of plane geometry. When the 337 institutions with PMP were asked what percentage of their program is devoted to these topics, 53% answered less than 5%; 28% said between 5% and 14%; 5% answered between 15% and 24%; and 12% responded at least 25% of their PMP is devoted to these topics or there is a separate course in plane geometry. Of the 40 schools in the last group, 9 are IGP and 28 are TYC.

Textbooks. Over 200 different titles were obtained from the question which asked schools to list the textbooks used in their PMP. The majority of titles were used in at most two of the responding

institutions. The most popular texts, used by between 5% (18) and 7% (22) of the schools, are the following (listed by author, where B = beginning, elementary or introductory algebra and I = intermediate algebra): Alwin and Hackworth (B), Drooyan and Wooten (B), Drooyan and Wooten (I), Keedy and Bittenger (B), Keedy and Bittenger (I), Moon and Davis (B). Of the schools using one or more of the four beginning algebra books listed above, 14 are IGP and 55 are TYC.

Eighteen schools have in use textual materials which were developed by the institution and are not in print. Thirteen schools listed Newmeyer and Klentos (I). The following is a list of authors mentioned by at least five and no more than ten institutions: Ablon, et al.; Barnett; Dolciani and Sorgenfrey; Drooyan, Beckenback, Wooten; Forman and Gavinin; Heywood; Keedy and Bittenger (arithmetic); Lial and Miller (B); Lial and Miller (I); McHale and Witzke; Moon and Davis (arithmetic and algebra); Munem; Munem and Tscheirhart; Reese and Sparks; Stein; Stockton; Swokowski; Washington; and Wood.

Mixed-media aids were reported to be available for student use in 36% of the institutions with PMP. The most frequently mentioned type is tape cassettes; those by the Charles Merrill Company, for use with the Moon, et al. texts, were reported by 8% of PMP. Some schools had developed their own tapes, film strips or television programs. The use of the computer in conjunction with the instruction was reported by 5% of the PMP.

Tutors are reported to be available for in-class use, or in a mathematics laboratory if this is the site of instruction, in 31% of the schools. Tutors are provided on an out-of-class basis in 65% of PMP.

III. Instructional Types.

The questionnaire distinguished two dimensions of a program of instruction: Form of instruction -- the means by which the PMP material is presented to the student; and the temporal organization of the material -- the pacing and grouping of the subject content. Schools were asked to describe their method of instruction in the PMP according to several alternatives within each of these dimensions. If none of the alternatives within a dimension applied, there was space for the respondents to provide their own description. Upon tabulation virtually all programs could be described in the form of instruction dimension by one of four alternatives and in the temporal organization dimension by one of three alternatives. These are described below:

Form of Instruction

F-1. Students meet with the instructor as a group; lectures are given to this group as a whole.

F-2. Students are given lectures in a group, but this group is also subdivided into sections for additional instruction.

F-3. Students study individually with self-guided materials; they may meet in a classroom, mathematics laboratory or only on an individual basis with the instructor.

F-4. This is a combination of F-1 and F-3.

Temporal Organization

O-a. This is the traditional classroom organization: the pace is essentially predetermined; student credits (grades) are based on overall, term-long performance.

O-b. Material of the program is divided into a set or sequence of learning units, each of which is of fixed length; each unit may be repeated until the desired grade is obtained and/or a predetermined level of performance is demonstrated.

O-c. Material of the program is divided into a set or sequence of learning units; the amount of time spent on each unit is flexible, depending on the grade desired and/or the level of performance required.

Every PMP has components in both of the dimensions described above. Thus the four forms of instruction and the three temporal organizations together described twelve instructional types of PMP. These types will be denoted by the number corresponding to the component of the form of instruction dimension and the letter corresponding to the component of the temporal organization dimension. For example, a program with the F-2 form of instruction and the O-c temporal organization is of instructional type 2c. Table 4 gives the occurrences of each instructional type for TYC, IGP and all categories of institutions.

It should be noted that the responses in Table 4 represent descriptions of the primary instructional type in use. Roughly one-fifth of the responding schools indicated that another type is also

Table 4: Instructional Types by Institutional Category

		TEMPORAL ORGANIZATION											
		O-a			O-b			O-c			Row Total		
		IGP	TYC	All	IGP	TYC	All	IGP	TYC	All	IGP	TYC	All
Form of Instruction	F-1	102	75	201	7	4	15	5	6	12	115	85	228
	F-2	8	4	12	1	2	3	0	1	1	9	5	16
	F-3	2	7	9	4	2	6	14	35	52	20	45	67
	F-4	2	3	5	0	2	2	2	9	14	4	14	21
	Total	114	89	227	12	10	26	21	51	79	148	149	332

used in different courses of the PMP or in different sections of the same course. For example, of the 201 schools using the 1a approach, 23 also listed different approaches; and of the 52 schools using the 3c approach, 16 also used the traditional (1a) approach. While these alternate approaches are not taken into account in the analysis of this paper, there was a systematic method of recording one primary approach for schools listing more than one: If the different instructional types are used in different courses, the type of the lower level course was selected; if both types occur in different sections of the same course, the less traditional approach was recorded.

From Table 4 it is evident that instructional type 1a is used most frequently; it is found in 61% of all institutions with PMP. The second most frequently used type is 3c, 16%. The next most frequently used types, 1b, 4c, 1c and 2a, are each used in 4% or 5% of the PMP.

Table 5: F-1 and 1a Group Size

Group Size	Under 20	20-24	25-29	30-34	35-39	40-49	Over 49	Total
# F-1; All	15	34	44	65	32	18	13	221
# 1a; IGP	3	14	17	30	19	8	3	99
# 1a; TYC	4	10	18	26	10	7	1	73
# 1a; All	11	29	41	59	30	16	10	196

The 1a approach is the primary approach in 68% of IGP with PMP and 50% of TYC. The 3c approach is found in 9% of IGP and in 23% of TYC. We shall give some characteristics of each of the more important instructional types.

The 1a approach as well as all other types (1b, 1c) with the F-1 form of instruction uses the group lecture as a means of instruction. Table 5 presents the distribution of the average number of students per classroom as reported by institutions which have the F-1 form of instruction. Distributions are also given by institutional category for the 1a instructional type which is the most numerous type with the F-1 form of instruction. Note that 37% of IGP with 1a type of PMP have very large classes (over 34) as compared with 25% of TYC with 1a approach. (If we restrict our attention to the 1a approach in schools with PMP enrollment of over 400 per year, these percentages become 49% of IGP and 29% of TYC, respectively.)

Mixed-media aids are available for student use in 25% of all 1a PMP. Tutors are available or are used in the classroom in 17% of 1a programs and outside of class in 65% of these programs. While the percentage of schools with 1a approach having tutors available outside of class is the same as this percentage for all PMP, the percentage use of in-class tutors is less (31% for all PMP). Similarly, mixed-media aids are less available in 1a programs (36% in all PMP).

The 3c approach is the second most commonly occurring instructional type. This approach differs from the 1a approach in both programmatic dimensions. In terms of the form of instruction dimension the F-3 approach is used. Thus group lectures are not used to transmit the PMP material; this is accomplished on a more individual basis. Students work individually, usually with the availability of aid of an instructor and/or tutor. In 3c PMP, students work regularly with one or several of the following types of materials: tape recordings, slides, film strips, programmed texts and workbook type texts. In 73% of the 3c type PMP, tutors are used or are available for use on an in-class basis; 65% of these programs use mixed-media aids (although in some programs this is in a supplemental capacity). Because of the individual nature of this instruction, classroom meetings are not required. Thus, of 48 3c type programs, only 42% meet in a classroom; an additional 21% meet only individually with the instructor, either on a regularly scheduled or a drop-in basis. Thirty-eight percent (38%) of 3c PMP meet in a mathematics laboratory (also called a mathematics learning center). A mathematics laboratory is usually a large room which may contain mixed-media aids. It

is usually staffed by mathematics instructors, student tutors and perhaps a full-time paraprofessional. Mathematics laboratories are usually open a large number of hours per week. In some programs, students are required to be in the lab a specified number of hours each week (at their choosing); in other programs, students need only come to take tests.

The 3c approach also differs from the 1a approach in that programmatic dimension which describes the pacing of the material. In 3c programs the subject material is divided into a set or sequence of learning units. Students more or less determine how much time they spend on each unit. To complete a unit students must pass a test with a predetermined minimal score (over 90% of 3c PMP have this feature). In the typical 3c program the number of units is such that the average time spent on each unit is between 1 and 1.5 weeks. In those 3c PMP giving figures on the number of steps, the average length of time per step is between one-half and two weeks for 90% of these programs.

Within the 3c classification there is a variety of different approaches. There are also a number of names associated with these different approaches. The following is a list of some of the names often associated with programs of the 3c type; however, their use is by no means standardized: Audio-tutorial, Keller plan, the laboratory approach, the modular approach, personalized or individualized instruction, programmed instruction, self-paced instruction. Descriptions, discussions and analyzes of some of the 3c variations are found in the following references (not all apply solely to PMP):

[4;5;6;8;9;12;14]. Also see publications of the Center for Personalized Instruction, Georgetown University.

The remaining instructional types discussed here are less common than the two approaches discussed above. The 1b approach uses the F-1 (lecture) format, but the program is divided into discrete steps of fixed length. Each step may be repeated. The lengths of these units are somewhat longer than those of the 3c approach--in two-thirds of the 1b programs this length is at least two weeks. Students sometimes change instructors after completing or failing to complete a unit. About one-third of the programs have tutors for in-class use and about one-third have mixed-media aids available. As with the two previously mentioned types, about two-thirds of the 1b PMP have tutors available out of class. Common names for the 1b approach include "modular approach" and "mini-course approach." This instructional approach to preparatory mathematics is described in [1] and similar approaches in other mathematical courses are described in [10] and [11].

A word should be said about programs of type 1c and 4c. The number of institutions with one of these types is about 8% of all PMP. What programs of either type have in common is that there is some group lecture involved in the presentation of the material and there are allowances for the students to proceed through the material at different rates. However, within this 8% group there are wide variations. Some have lecture presentations exclusively with the possibility of taking tests at different rates. Other have more organized support for those who have not kept pace with the lectures such as mathematics laboratories. These latter programs may really be two separate types of programs (1a and 3c) with students moving from one approach to the

other as necessary. Other programs in the 8% group are essentially 3c type programs with optional and/or occasional lectures to supplement and enrich the individual study.

The 2a approach with a large group lecture accompanied by smaller group meetings is used by a few schools. However, the size of the lectures is usually not very large (in two schools between 50 and 75; in three schools between 75 and 125; and in two schools over 250; the remaining five are all below 50).

It is possible to have a 3a approach. An example of this is the PMP of Fullerton Community College, California. The students primarily work individually in a media center with tape cassettes which accompany the textbooks (Moon, Davis, et al.). This is the F-3 form of instruction. However, students are required to attend weekly meetings which are primarily used for administering weekly quizzes on the course material scheduled for that week. This is a O-a temporal organization.

IV. Evaluation.

In this section we will investigate how the respondents to the questionnaire evaluated their PMP. We will analyze these responses in terms of various programmatic and institutional characteristics. Most of this analysis is based on two different types of judgments given by the respondents: A judgment on the success of the PMP (JPS = judgment of program success); and an estimation of the percentage of students successfully completing the program (RRSS = reported rate of

student success). Much of the analysis is restricted to institutions which are in either the IGP or TYC institutional categories.

Some of the analysis of this and the following section will attempt to infer characteristics of the various populations from which our data were obtained. This involves making the appropriate assumptions of randomness of the samples and distributional characteristics of the sampled population. The statistical significance of each inference is usually tested using either the chi square statistic or the t-statistic (in a few cases the approximate t-statistic). The chi square statistic is used to test the hypothesis of independence of two discrete variables and the t-statistic is used to test the hypothesis of the equality of means of a variable for two groups (a two-sided test). When these tests are used, the only indication will usually be a statement concerning the conclusion of the test and its level of significance (l.s. = the probability, given independence or equality of means, of obtaining a magnitude of the appropriate statistic which is at least as large as that obtained from the data). We will accept the tested hypothesis if the l.s. is greater than .10; reject if l.s. < .05; and leave open to question (questionably significant) those hypotheses with $.05 \leq$ l.s. ≤ 0.10.

The question which asked for a judgment of success of the PMP, JPS, was provided with four response blanks, marked: Very successful (VS); somewhat successful (SS); somewhat unsuccessful (SU); and unsuccessful (U). Some respondents marked both VS and SS and some marked both SS and SU. Table 6 gives by institutional category, the number of schools giving each of these six responses.

Table 6: Judgment of Program Success (JPS)

Response	None	VS	VS and SS	SS	SS and SU	SU	U	Total
IGP	18	28	2	89	2	9	2	150
TYC	6	33	3	96	6	7	0	151
All	24	68	6	211	8	18	2	337

In the analysis which uses JPS, we will neglect those with no response and group the remaining responses as follows: High (HJPS) - those with both VS and SS are grouped together with the VS responses; Mixed (MJPS) - those with both SS and SU are grouped with SS responses; and Low (LJPS) - those with SU and U are grouped. From Table 6 we see that for IGP the number of PMP in each of the above groups is: HJPS = 30, MJPS = 91 and LJPS = 11. For TYC these numbers are 36, 102 and 7, respectively. These two distributions are quite close and testing for independence we conclude that the distribution of JPS is independent of institutional category, IGP or TYC (l.s. = .48); and thus the institutional category of the respondent does not seem to affect the respondent's judgment of PMP success.

Schools were asked to list the criteria on which their JPS were based. These responses were categorized and tabulated; up to three responses were recorded for each school. The following is a list by institutional category of all items mentioned by over 10% of the institutions (the percentages are the frequency of responses to the number of schools in the category): IGP - achievement in subsequent courses (AS), 41%; student attitudes (SA), 34%; faculty attitudes (FA),

25%; success or completion rate (SR), 24%; and for TYC - SR, 42%; AS, 38%; SA, 32%; FA, 21%; and the number of drops (ND) or failures (the negative side of SR), 19%.

A comparison of the above lists indicates that student survival (SR and ND) plays a larger role in judgments of TYC than in those for IGP (6% of IGP listed ND). This fact seems to be reflected in some of the later results.

How do the JPS for PMP vary between programs with different characteristics? We shall investigate this question looking at programs with different dimensional aspects and program types as well as different PMP enrollments and program lengths. Table 7 summarizes the survey data which are relevant.

From Table 7, rows one and two, and the three most right columns, we compute that, if all categories of institutions are considered, programs with the F-1 form of instruction receive HJPS by 18% of these institutions, MJPS by 74% and LJPS by 8%. While PMP with F-3 form of instruction received HJPS by 43%, MJPS by 57% and LJPS by 0%. Testing for independence (l.s. < .001), we conclude for the general population of PMP, judgments of program success depend on which form of instruction (F-1 or F-3) is in use, with a higher percentage of PMP with the F-3 form of instruction receiving HJPS. This conclusion holds if we restrict our attention to TYC (l.s. < .01). However, this conclusion is of questionable significance (l.s. = .09) for the IGP. However, even with the last group, our sample showed that the percentage of HJPS for F-3 forms of instruction (HJPS = 37%) is almost twice the corresponding percentage for F-1 forms (HJPS = 19%).

Table 7: Judgment of Program Success and Programmatic Aspects

			Judgment of Program Success								
			IGP			TYC			All Categories		
	Row		HJPS	MJRS	LJPS	HJPS	MJPS	LJPS	HJPS	MJPS	LJPS
Programmatic Aspects	1	F-1	19	72	11	14	64	4	39	159	17
	2	F-3	7	12	0	19	24	0	28	37	0
	3	O-a	19	73	10	14	68	5	39	157	17
	4	O-c	7	11	1	19	34	1	28	47	2
	5	1a	15	66	10	12	58	4	33	140	16
	6	3c	5	9	0	16	19	0	23	29	0
	7	< 18 weeks	23	66	7	9	37	0			
	8	≥ 18 weeks	7	21	3	26	60	7			
	9	< 400	14	47	6	11	39	4			
	10	≥ 400	16	40	5	25	57	3			
	11	1a, ≥ 400	7	27	5	7	30	3			
	12	3c, ≥ 400	4	3	0	12	13	0			

Similar conclusions are reached from a comparison of JPS for PMP with the O-a and O-c temporal organizations (Table 7, rows 3 and 4). For all categories of institutions taken together, PMP with the O-a organization received the following JPS distribution, by percent: HJPS, 13%; MJPS, 74%; and LJPS, 8%. The corresponding percentages of PMP with the O-c organization are: HJPS, 36%, MJPS, 61%; and LJPS, 3%. Testing for independence (l.s. < .01) we conclude that for the general population of PMP, judgment of program success depends on the temporal organization (O-a or O-c), with a higher percentage of PMP with the O-c organization receiving HJPS. This conclusion holds for

the category of TYC (l.s. = .02). For the category of IGP, we cannot reject the assumption that JPS is independent of temporal organization (l.s. = .20); however, in our sample, the percentage of HJPS among O-c programs is about twice this percentage for O-a programs.

The classification of program types presented in Section III is based on the two programmatic dimensions discussed in the previous two paragraphs. Since programs with the F-3, respectively O-c, dimension are given higher JPS then programs with the F-1, respectively O-a, dimension, we would expect 3c instructional types to receive higher JPS than the 1a type. And this is the case. For all institutional categories together (Table 7, rows 5 and 6, three right columns), PMP with the 1a type instruction received the following JPS, by percent: HJPS, 17%; MJPS, 74%; and LJPS, 8%. And those PMP with 3c instruction received: HJPS, 44%; MJPS, 56%; and LJPS, 0%. Testing for independence (l.s. < .001) we conclude that for the general population of PMP, JPS depends on the type of instruction (1a or 3c), with PMP of 3c type receiving a higher percentage of HJPS. The conclusion holds when we restrict our attention to TYC (l.s. < .01). For the IGP, while a higher percentage of 3c programs received HJPS than did 1a programs (36% compared with 16%), we cannot reject the assumption of JPS being independent of program type (l.s. = .14).

Two additional aspects of PMP were tested for independence of JPS: The number of weeks of instruction and the annual enrollment. As indicated in Table 7, rows 7 through 10, we have compared by category the JPS distributions in schools with less than 18 week PMP to those in schools with at least 18 week PMP and, similarly, with annual PMP en-

rollments below and above 400. For the IGP category, the differences in the JPS distributions in both cases is minimal; and, as partitioned here, JPS is independent of length of program (l.s. = .99) and size of annual enrollment (l.s. = .8). For the TYC category, the conclusions of independence of JPS and program length (l.s. = .07) and enrollment (l.s. = .7) also hold; however, it is of questionable significance in the case of program length. In TYC a higher percentage of both HJPS and LJPS were given for PMP with length of at least 18 weeks.

Although we found that JPS is independent of whether the annual PMP enrollment is above or below 400, in our sample of TYC a higher percentage of PMP with enrollments over 400 received HJPS than did those with enrollments under 400 (29% and 20%, respectively). This fact may bring into question our earlier test comparing JPS distributions in 1a and 3c type programs since 56% of all PMP in TYC have enrollments over 400 while this is true of 71% of the 3c type PMP in TYC. Thus we tested for independence of JPS with respect to 1a and 3c type PMP in TYC with annual PMP enrollments over 400 (Table 7, rows 11 and 12). We see that in this group of institutions our earlier conclusion holds: JPS depends on type of instruction, 1a or 3c (l.s. < .05); a higher percentage of 3c programs receive HJPS.

The second type of judgment used here to evaluate various aspects of PMP is based on the responses to the question asking for the percentage of students successfully completing the PMP (reported rate of student success = RRSS). Table 8a presents the responses to the question in terms of the two major categories of institutions.

Table 8a: Reported Rate of Student Success (RRSS)

Per-cent	No Reply	0-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-100	Total
IGP	27	1	0	0	3	5	17	22	30	45	150
TYC	14	1	1	2	7	26	44	20	20	16	151
All	47	2	1	3	10	33	62	53	55	71	337

In the following data presentation of RRSS we will neglect the no replies and combine the reported percentages into three groups, as with JPS responses: High RRSS (HRRSS) - at least 75%; Medium RRSS (MRRSS) - at least 45% and less than 75%; and Low RRSS (LRRSS) - less than 45%. However, unlike the JPS data, we can analyze the RRSS data using the means of these responses by institutions sharing particular programmatic aspects: No replies are neglected and 1 is assigned to all percentages between 0 and 14, 2 to all percentages between 15 and 24, ..., 9 to all percentages 85 and over; these assigned numbers are averaged. Table 8b summarizes the RRSS using these combining methods.

For Table 8b, it is evident that there are differences between the RRSS in IGP and TYC: 61% of IGP have HRRSS while 26% of TYC do. Testing for independence (l.s. < .001) we conclude that RRSS depends on institutional category. In fact, testing for equality of means (l.s. < .001) we conclude that the mean of RRSS is significantly higher in IGP than TYC. Since our sample is composed mainly of these

Table 8b: Reported Rate of Student Success

	HRRSS	MRRSS	LRRSS	Mean
IGP	75	44	4	7.6
TYC	36	90	11	6.4
All	126	148	16	

two large institutional categories and since these groups give different RRSS, further analysis will be restricted to the responses of each of these groups separately. Table 9 summarizes the RRSS for IGP and TYC in terms of various aspects of PMP.

Rows 1, 2 and 3 compare the two evaluative responses used in this paper. It is interesting to note that while the distributions of JPS are quite similar for IGP and TYC (see Table 6), this is not the case of RRSS. The mean RRSS of PMP with HJPS is 7.9 for programs in IGP and 6.8 for programs in TYC. Within each of categories the means of RRSS responses for the three judgments: HJPS, MJPS and LJPS are not equal (ANOV: l.s. = .01 for IGP and l.s. < .001 for TYC). For both institutional categories means of RRSS for the MJPS and LJPS responses are significantly different (l.s. < .01 in both cases). However, for IGP, there is no significant difference between the means of RRSS for HJPS and MJPS (l.s. = .78); while, for TYC, the equality of these means, is questionable (.09 < l.s. < .10). Thus, while in both institutional categories, JPS reflect how many students are viewed as successful, this tendency seems more pronounced in TYC. This may reflect the fact discussed earlier in this section that TYC more frequently list as criteria for JPS factors which involve student survival in the PMP.

Table 9: RRSS and Programmatic Aspects

		IGP				TYC			
Row	Aspect	HRRSS	MRRSS	LRRSS	Mean	HRRSS	MRRSS	LRRSS	Mean
1	HJPS	18	7	1	7.9	12	22	1	6.8
2	MJPS	51	28	2	7.8	23	64	7	6.3
3	LJPS	2	8	0	6.5	0	2	3	3.8
4	F-1	66	30	2	7.8	24	46	8	6.5
5	F-3	1	11	2	6.1	6	31	3	6.1
6	O-a	66	32	0	7.9	25	46	8	6.4
7	O-c	1	10	3	5.9	9	36	3	6.2
8	1a	59	28	0	7.9	21	39	8	6.4
9	3c	0	8	2	5.8	3	27	3	5.9
10	< 18 weeks	57	32	4	7.6	17	28	1	6.9
11	≥ 18 weeks	15	10	0	7.7	19	59	8	6.2
12	enrol. < 400	46	16	1	7.9	26	26	2	7.1
13	enrol. ≥ 400	25	28	2	7.3	10	59	8	5.9
14	1a, ≥ 18	11	4	0	8.0	8	24	6	6.0
15	3c, ≥ 18					2	20	2	5.9
16	1a, ≥ 400	19	17	0	7.4	6	25	6	5.9
17	3c, ≥ 400	0	4	1	5.6	0	20	3	5.5

How does RRSS vary with some of the important programmatic aspects? In terms of the form of instruction dimension (Table 9, rows 4 and 5), in both institutional categories the mean RRSS for the schools in our sample with the F-1 form is higher than the schools

with the F-3 form. Testing for equality of means we conclude that the mean RRSS for F-1 PMP is significantly different (and higher) than the mean RRSS in F-3 programs for the IGP (l.s. < .001) but not for the TYC (l.s. = .24). Quite similar results are obtained for the temporal organization dimension (Table 9, rows 6 and 7). For both categories, O-a PMP had higher mean RRSS than did the O-c PMP. And testing for equality of means we conclude the mean RRSS for O-a PMP is significantly different (and higher) than this mean for O-c PMP in IGP (l.s. < .001) but not in TYC (l.s. = .44).

Combining the programmatic dimensions and comparing RRSS for the main two program types, 1a and 3c (Table 9, rows 8 and 9), we conclude that in IGP there is a significant different (l.s. < .001) between the mean of RRSS in PMP of the 1a type (7.9) and the mean of RRSS in PMP of the 3c type (5.8); while in TYC there is no significant difference (l.s. = .14) in these means (1a, 6.4; 3c, 5.9).

We next check the effects of two programmatic aspects on the RRSS: Length of PMP and size of student enrollment. Table 9, rows 10-13, reports by institutional category the RRSS distributions and means for PMP under 18 weeks in length and at least 18 weeks in length; also reported are these distributions and means for PMP with annual enrollments under and over 400. For IGP there is no significant difference in the means of RRSS for the two program lengths (< 18, 7.6; ≥ 18, 7.7; l.s. = .8); however, for the different enrollment sizes the difference in means is significant (< 400, 7.9; ≥ 400, 7.3; l.s. = .02). For TYC both differences are significant (< 18, 6.9; ≥ 18, 6.2; l.s. < .01) and (< 400; 7.1; ≥ 400; 5.9; l.s. < .001).

Since the majority of TYC have PMP with enrollments over 400 annually and are of lengths exceeding 18 weeks, the conclusion that there is no significant difference in the means of RRSS for 1a and 3c programs is checked (see Table 9, rows 14-17): For TYC with PMP enrollments of at least 400, no significant difference (l.s. = .35); for PMP of length at least 18 weeks, no significant difference (l.s. = .78). We also test equality of means of RRSS of 1a and 3c PMP in TYC with PMP enrollments of at least 400 and with program lengths of at least 18 weeks: No significant difference (1a, 5.7; 3c, 5.5; l.s. = .56).

Why is it that in our sample PMP with 1a type instruction consistently have higher mean RRSS than do 3c type PMP? This is especially interesting when it is observed that 3c PMP tend to receive significantly higher JPS and that with higher JPS tend to go higher RRSS. It may be that there is less student success in 3c type programs and that the phenomenon of higher JPS in these 3c programs is similar to that in which IGP and TYC have significantly different RRSS and yet the same JPS distributions. However, before drawing this conclusion several factors should be considered. As mentioned previously in [2], <u>there is a different meaning to success in 3c programs than in 1a programs</u>. In a 1a PMP success relates to overall performance, perhaps a qualitative judgment of performance on a final examination or perhaps a minimal score to pass the course. In a 3c PMP success usually means completing all or most of the learning unit, each with at least a minimal score.

A second factor to be considered when comparing RRSS for 1a and 3c PMP is that because of the individual nature of the 3c approach better records are usually kept on the students. This coupled with the more well-defined meaning of success may make the information on student success more reliable in 3c PMP than in 1a programs. Some evidence for this may be found in our sample of TYC. One would expect that for a given group of schools more accurate knowledge of student success (however defined) would result in a smaller variance of the RRSS for this group. Also, one would expect that the more accurate is the knowledge of RRSS, the greater would be the relative contribution of other factors to the total variance and therefore the greater would be the effect on the variance of a reduction in the contribution of these factors. Comparing the variances of RRSS in 1a and 3c PMP in (1) all TYC, (2) TYC with PMP of at least 18 weeks and (3) TYC with PMP of at least 18 weeks and with enrollments over 400, we see the variances in 1a PMP are (1) 3.1, (2) 3.3 and (3) 3.2, respectively; while for 3c programs the variances are (1) 1.4, (2) 1.0 and (3) 0.5, respectively. This reduction in the variance of RRSS in 3c programs is as might be expected. Also, in each of the three groupings of TYC, the variances for 1a and 3c PMP are significantly different (F-test, for each case l.s. $< .01$). (This fact required the use of the approximate t-statistic in some of the earlier analysis.)

Finally, we will analyze the relation between the reported class size for PMP with the 1a approach and the two types of judgments: JPS and RRSS. Table 10 presents the relevant information by institutional category and three class size groupings. Within each category, JPS is

Table 10: 1a Class Size, JPS and RRSS

		IGP				TYC			
		JPS			RRSS	JPS			RRSS
		HJPS	MJPS	LJPS	Mean	HJPS	MJPS	LJPS	Mean
class size	20-29	4	21	1	8.0	4	23	1	6.7
	30-34	4	19	2	8.0	4	18	1	6.3
	≥ 35	7	23	5	7.6	3	13	2	5.8

independent of class size (IGP, 1.s. > .6; TYC, 1.s. > .8). And while the sequence of means, particularly in the TYC, seem suggestive, an analysis of variance indicates that there are no significant differences between the means in either category (IGP, 1.s. = .34; TYC, 1.s. = .24). Thus, 1a class size does not seem to significantly affect either of the two evaluative responses: JPS or RRSS.

V. Change.

In this section we will discuss some of the changes which have taken place in PMP in recent years and analyze some of the ingredients of this change.

An indication of the rate of change in PMP is obtained from the responses to a question which asked each institution to give the length of time the current approach of their PMP had been used. Table 11a summarizes these responses.

For later analysis and data presentation we will neglect the no reply responses and group the indicated years in use as follows:

Table 11a: Years with Current Approach

Years	No Reply	≤ 1	(1,2]	(2,3]	(3,4]	(4,5]	(5,6]	(6,7]	(7,8]	> 8
IGP	12	26	24	18	13	11	8	5	3	30
TYC	7	13	17	26	19	17	13	5	15	19
All	19	43	50	53	35	34	22	10	20	51

High change (HC) - two years or less; medium change (MC) - over two and no more than eight years; and low change (LC) - over eight years. We will also use a truncated mean by assigning the following numbers to the years in use and averaging these numbers: 1 - one year or less; 2 - (1,2]; 3 - (2,3], ..., 9 - over 8 years. Table 11b presents the data of Table 11a with this grouping.

From Table 11b, a test for independence reveals that the distribution of years with current approach significantly depends on institutional category (l.s. < .001). From this table we find that while in our sample a higher percentage of TYC have made changes in their PMP in the last eight years than have IGP (TYC, 87%; IGP, 78%), a higher percentage of IGP have made changes in the two years prior to the questionnaire: (TYC, 21%; IGP, 36%). This trend is further substantiated by the average ages of PMP with the various programmatic aspects. These means as well as distributions of years with current approach are given in Table 12.

First note from Table 12 that instructional approaches with the traditional dimensional aspects (F-1 and O-a) and types (1a) have been in use longer than the corresponding nontraditional dimensional as-

Table 11b: Years with Current Approach

	HC	MC	LC	Mean
IGP	50	58	30	4.4
TYC	30	95	19	4.8
All	93	174	51	4.5

pects (F-3 and O-c) and types (3c). In IGP the differences of the corresponding means is evident (l.s. < .01, in each case). In TYC, there are significant differences between mean years in use for F-1 and F-3 PMP (l.s. = .04) and between the means for 1a and 3c programs (l.s. = .04); however, there is no significant difference between the means for O-a and O-c programs (l.s. = .15). Thus nontraditional approaches have been in existence in PMP for a shorter time than the traditional approaches. It also appears evident that nontraditional PMP have been in existence for less time in the IGP than in the TYC. For example, the mean of the years in use variable for 3c PMP is 2.1 in IGP and 4.3 in TYC. Looking at the distributions in Table 12, 71% of 3c PMP in IGP had been using the 3c approach for two years or less (at the time of the questionnaire); while, the corresponding percent in TYC was 20%. The years in use distribution in Table 12 for 3c type PMP depends on institutional category (l.s. < .01).

In order to gain some information about the nature of change, schools which had recently made or were planning to make major changes in their PMP were asked to complete some questions regarding this process. They were asked to describe the changes, to give sources of

Table 12: Years with PMP with Different Programmatic Aspects

	IGP				TYC			
	HC	MC	LC	Mean	HC	MC	LC	Mean
F-1	29	47	29	5.0	13	54	14	5.2
F-3	14	5	1	2.4	10	28	5	4.2
O-a	29	46	30	5.1	15	55	14	5.1
O-c	14	7	0	2.2	10	37	4	4.5
1a	23	41	29	5.3	10	47	14	5.4
3c	10	4	0	2.1	7	24	4	4.3

information and support which may have aided the change process, to characterize individuals who implemented or planned the change and, in case of past change, to compare the effectiveness of current approaches with the earlier approach.

Table 13 summarizes the responses to the question of whether major changes had taken place in the last six years and/or was planned. While a higher percentage of TYC reported major change in the last six years (61%) than did IGP (52%), whether or not major change had taken place is independent of institutional category (l.s. = .16). Also, as expected from the data on age of current PMP, a higher percentage of IGP planned major changes (23%) than did TYC (16%); however, whether or not change was planned is independent of institutional category (l.s. = .16). Also whether or not change was planned is independent of whether major change had been effected in the last six years. This is true for all the groups: all institutions (l.s. = .72), IGP (l.s. = .42) and TYC (l.s. > .8).

Table 13: Major Change in Last Six Years or Planned

	IGP		TYC		All	
	Yes	No	Yes	No	Yes	No
Change in Last Six Years	75	69	89	58	182	144
Planning Change	33	107	25	124	62	272
Planning Change, Given Past Change	19	53	14	75	35	143
Planning Change, No Past Change	14	54	10	48	26	118

In addition, whether or not major changes had been made or planned seems to have no significant effect on the evaluative judgments, JPS and RRSS, and conversely. A summary of the relevant information is found in Table 14. The distribution of JPS is independent of whether or not major change had been reported in the last six years (IGP, l.s. = .38; TYC, l.s. = .66). JPS distribution is also independent of whether or not change is planned, although the significance of this result is questionable in the TYC case (IGP, l.s. > .95; TYC, l.s. = .07). In the TYC case, 12% of those planning change reported HJPS and 28% of those not planning change did so. Turning to the reported rate of student success, there are no significant differences in the means of RRSS for schools which had or had not effected change in last six years (IGP, l.s. = .20; TYC, l.s. = .54). Neither are there significant differences between the means of RRSS for schools which planned or did not plan major changes (IGP, l.s. > .95; TYC, l.s. = .44).

While past or future actions regarding change do not seem to significantly affect evaluative judgments concerning the success of

Table 14: Change and Evaluative Judgments - JPS and RRSS

	IGP				TYC			
	JPS			RRSS	JPS			RRSS
	HJPS	MJPS	LJPS	Mean	HJPS	MJPS	LJPS	Mean
Past Change	17	43	4	7.5	22	61	3	6.3
No Past Change	12	48	7	7.8	14	39	4	6.5
Planned Change	7	21	3	7.6	3	19	3	6.2
No Planned Change	22	67	8	7.6	33	83	4	6.4

the current program or student success, schools which had made major changes in the last six years overwhelmingly considered their current programs an improvement over the past programs. Of the 182 institutions which had made changes, 113 gave a comparison between the old and new approaches; 85% of these 113 institutions preferred the current approach and 59% of the 113 stated that this comparison was based on student performance: Grades, test scores and/or performance in subsequent courses.

What are some of the main directions of this past change? Of the 182 schools which had made major changes, 166 indicated the nature of this change. We will comment on those types of changes which occurred in at least 10% of these institutions. The largest trend was away from traditional instruction: 40% moved away from 1a type instruction (and an additional 4% away from large lectures). Four-fifths of these schools presently use an instructional approach with either an O-b or O-c temporal organization or an F-3 form of instruction. The second most numerous type of change, occurring in 17% of

those having made change, involved the creation of a PMP or the addition of a new course (usually at a lower level) to an already existing program. This trend shows the growing need for preparatory mathematics instruction as well as the recognition of a need for an institutional response to this growth. The third major trend, occurring in 14% of the 182 institutions, was a movement away from the use of programmed materials. It is not clear from these responses whether this trend represents a reaction against the material itself or against the instructional approach which accompanied the use of the material (these materials are often used with 3c type programs or other types with an F-3 component and "programmed" is used to describe the approach). While educators have questioned the effectiveness of strictly programmed materials because the rigid structure of these materials may hinder some important learning behaviors, the negative questionnaire responses probably reflect experience with program designs which neglect important motivational features. Aspects of this problem are discussed in [6] and [7] ([3] may also be of interest).

Of the 61 schools planning major changes in their PMP, 58 gave some indication of the direction of this change. Of these, 26% planned to segment the program into more learning units (development of the O-b or O-c components). Some of the schools comprising this 26% already had O-c organizations, but were planning to more finely divide the program content (this is mentioned in [6] as a method to increase student motivation). Of the 58 institutions, 17% planned to offer a new course (usually at a lower level) in their PMP. Fourteen percent planned changes in the F-3 direction (self-pacing, programmed

material, audio-tutorial approaches). Another 14% planned to change the program content and not the instructional approach. Twelve percent (7 institutions) planned to incorporate into the PMP the use of the computer; this is an increase of 41% over the current computer use (17 schools).

Schools which had made major changes and/or planned major changes in their PMP were asked about the sources of information from which ideas for change had come. They were also asked about sources of support received from outside the department which helped and/or would help to implement the changes.

Sources of information were indicated by 148 different schools. Besides general statements about conferences (29%) and journals (28%; 11% mentioned journal names), 22% mentioned visits to other institutions and 16% stated that the ideas for change had been generated internally. Two additional sources should be indicated, each received about 7% of the responses. One was the special workshops held in various areas of the country on the Keller plan, personalized systems of instruction or related 3c type approaches. Some of these workshops have been sponsored by the Center for Personalized Instruction, Georgetown University; others by the National Science Foundation. The second source of information mentioned by about 7% was representatives of textbook publishers.

Of the institutions having made and/or planning major program changes, 209 (with some multiplicity for those doing both) responded to the question about sources of extra-departmental support. Fifty-seven percent indicated that they received no such support and an

additional 12% indicated the support received was of an administrative nature (changes in scheduling, grade reporting, etc.). Thus two-thirds of the changes were without financial assistance. Fifteen percent received financial support from within the institution and 13% from outside: State (1%), Federal (10%) or private foundation (2%). Federal monies supported PMP changes in 4 IGP and 12 TYC.

Institutions participating in change were also asked to characterize the individuals who had implemented or planned the change. While the responses to this question were not tabulated, there seemed to be no common characteristics of those involved with change in terms of rank, tenure, or years in the department.

REFERENCES

1. L. J. Ablon, A modular approach to preparatory mathematics, American Mathematical Monthly, 79 (1972), 1126-1131.

2. R. M. Dahlke, Determining the best predictors of success and of completion or dropout in an individualized course in mathematical education, Journal for Research in Mathematics Education, 5, 4 (1974), 213-223.

3. B. A. Green, Suggestions for avoiding problems with PSI--Some do's and dont's, Education Research Center, M.I.T.

4. D. R. Horner, The 'lab' picture: progress or peril?, MATYC Journal, 8, 3 (1974), 37-39.

5. F. S. Keller, Goodbye teacher, Journal of Applied Behavior Analysis, 1 (1968), 79-89.

6. J. A. Kulik, C-L. Kulik and K. Carmichael, The Keller Plan in science teaching, Science, 183 (1974), 379-383.

7. K. Lindberg, A model for evaluating selected variables of preparatory mathematics programs in higher education (submitted).

8. A. Maltbie, R. G. Savage and J. L. Wasik, The operation and evaluation of a proctorial system of instruction in mathematics, American Mathematical Monthly, 81 (1974), 71-78.

9. E. Mattila, A continuous process program - from arithmetic to calculus, MATYC Journal, 8, 3 (1974), 21-25.

10. H. G. Moore, Precalculus mini-courses, self-pacing with constraints, American Mathematical Monthly, 81 (1974), 1019-25.

11. E. Oliver, A course in two-week units, Mathematics Teacher, 65 (1972), 145.

12. A. Pelusa and A. J. Baranchik, Self-paced mathematics instruction: a statistical comparison with traditional teaching, American Mathematical Monthly (to appear).

13. Yearbook of Higher Education 1973/4, Academic Media, NJ, 1973.

14. P. L. Young, H. E. McKean and F. L. Newman, A personalized system of instruction in an undergraduate mathematics service sequence, American Mathematical Monthly, 81 (1974), 767-775.

Appendix I: Institutions indicating PMP instruction of type 3c*

(Listed alphabetically by state)

Central Arizona College, Coolidge, AZ 85228
Maricopa Technical Community College, Phoenix, AZ 85004
University of Arizona, Tucson, AZ 85721

Cerritos College, Norwalk, CA 90650
Chaffey College, Alta Loma, CA 91701
City College of San Francisco, San Francisco, CA 94112
Merced College, Merced, CA 95340
San Diego State University, San Diego, CA 92115
San Jose City College, San Jose, CA 95114
Southwestern College, Chula Vista, CA 92010

Arapahoe Community College, Littleton, CO 80122
Metropolitan State College, Denver, CO 80204

Florida Technological University, Orlando, FL 32816
Hillsborough Community College, Tampa, FL 33622
Manatee Junior College, Bradenton, FL 33507
Palm Beach Junior College, Lake Worth, FL 33460
St. Petersburg Junior College, St. Petersburg, FL 33733

West Georgia College, Carollton, GA 30117

Chicago State University, Chicago, IL 60628
Illinois Valley Community College, Oglesby, IL 61348
Triton College, River Grove, IL 60171

De Pauw University, Greencastle, IN 46135
Valparaiso University, Valparaiso, IN 46383

Essex Community College, Baltimore, MD 21237
Harford Community College, BelAir, MD 21014

Clark University, Worcester, MA 01610

Lansing Community College, Lansing, MI 48194
Michigan State University, East Lansing, MI 48824
Wayne State University, Detroit, MI 48202

Meramec Community College, St. Louis, MO 63122

University of Montana, Missoula, MT 59801

Central Nebraska Technical University, Hastings, NE 68901

University of Nevada, Las Vegas, NV 89154

*The instructional types are described in Section III.

Rockland Community College, Suffern, NY 10901
Westchester Community College, Valhalla, NY 10595

Clackamas Community College, Oregon City, OR 97045
Lane Community College, Eugene, OR 97401
Mt. Hood Community College, Gresham, OR 97030

La Salle College, Philadelphia, PA 19141

Midlands Technical College, Columbia, SC 29250

Austin Peay State University, Clarksville, TN 37040
State Technical Institute, Memphis, TN 38134
University of Tennessee, Chattanooga, TN 37401

College of The Mainland, Texas City, TX 77590
Eastfield College, Mesquite, TX 75149
Lee College, Baytown, TX 77520
Mountain View Community College, Dallas, TX 75211

Seattle Central Community College, Seattle, WA
Spokane Community College, Spokane, WA 99203
Tacoma Community College, Tacoma, WA 98465

Appendix II: Institutions indicating PMP instruction of type 1b*

(Listed alphabetically by state)

University of Alaska, Fairbanks, AK 99701

Palomar College, San Mareos, CA 92069

Clayton Junior College, Morrow, GA 30260

Kapiolani Community College, Honolulu, HI 96814

Emporia Kansas State College, Emporia, KS 66801

Thomas More College, Ft. Mitchell, KY 41017

Bangor Community College of University of Maine, Bangor, ME 04401

Michigan Technological University, Houghton, MI 49931
Saginaw Valley College, University Center, MI 48710

Mankato State College, Mankato, MN 56001

Staten Island Community College, Staten Island, NY 10301
State University of New York Agricultural & Technical College, Delhi, NY 13753
City College of New York, New York, NY 10031

University of Akron, Akron, OH 44325

*The instructional types are described in Section III.